AID TRAINING SYSTEM FOR UPPER EXTREMITY REHABILITATION

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Abstract-**This research involves developing an aid training system for the upper extremity rehabilitation. Included in this system are a hand-training unit, a signal converting interface and a computer. The hand-training unit is a platform with multiple reed-relays and a arm-skate for the patients to operate on the platform. The selected items and figures on the computer activate specific designs linking with each reed-relay and are displayed on the computer screen. The patients then draw the same figures on the platform by the arm-skate with their hands. The corrections and time elapsed can be recorded and sent back to computer unit through the signal converting interface. The flexion, extension, and coordination of hand muscle will be achieved after repeatedly performing this training. Meanwhile, in addition to multiple training items of corresponding figures, this system also provides functions for building a patient database to offer clinicians scientific data for long-term monitoring the rehabilitation effects.**

Keywords- upper extremity rehabilitation, reed-relay, arm-skate

I. INTRODUCTION

This research developed an aid training system for upper extremity in coordination rehabilitation. The system has manual and virtual specific designs whose hands are paralyzed caused by hemiplegics. Through a specific processing system, corrections can be determined as the system is trained on the upper extremity coordinating.

Most of the patients whose IQ is normal only have language expression and muscle coordination obstacles. Therefore, rehabilitation training for muscle coordination in the upper extremity is essential and urgent. However, the present training system for upper extremity is limited to traditional remedies or some simple training tools that cannot efficiently guide patients into reconstruction procedures and targets. The current systems are also unable to offer clinicians with scientific data to evaluate the rehabilitation process [1], [2].

The main purpose of this research is to provide a specific design and determine its effectiveness through a specific processing system for repeatedly practicing, further enhancing a rehabilitation training system for upper extremity in coordination.

II. METHODOLOGY

The configuration of the aid training system for upper extremity rehabilitation is shown in Fig.1 which includes: (1) hand-training unit, (2) signal converting interface, (3) computer unit linking with hand-training unit. The hand-training unit as shown in Fig.2 includes a platform and a arm-skate, the platform has a operating areas suitable for manual actions. Its surface is smooth and flat, beneficial for arm-skate to move on the surface easily. As shown in Fig.1 and Fig.2, there are multiple sets of reed-relays set in the bottom of the platform. The reed-relays are constructed in the form of a 2-D of array. In the examples, 1125 sets of reed-relays are set in bottom area of the platform, 45(sets)* 25(sets) as a 2-D of array used for checking arm-skate position for patients' hands to move. Each reed-relays is linked with a computer through a signal converting interface unit.

For the arm-skate moved by patients' hands (as shown in Fig.2), 360∘slipping wheels provide free revolving set at the four corners of the arm-skate. The slipping wheels which resemble a universal joint, making the arm-skate can move in all directions. There is a magnet set at the central position under the arm-skate. The magnet and platform retains a regular and suitable distance (about 1mm). When the arm-skate moving on the platform, the magnet under its bottom will make reed-relays close/open set at corresponding position in the bottom of the platform.

A holding part slightly protrudes on the arm-skate surface in a specific shape, suitable for patient hand to support on it, and move on the platform arbitrarily. A sticky buckle firmly set on the wrist to prevent the arm-skate interfering with the patients' actions.

After repeatedly training, actions and muscle coordination in the upper extremity will gradually be improved and able to handle the arm-skate. For promoting the training effects, difficult arm-skate levels can be increased step by step in order to enhance the physical strength of the patient's hand and provide increased flexibility. The hand-training unit related could also include a force-resister (as shown in Fig.1 (c)), which is connected to the arm-skate by a traction lead. This force-resister can modulate the resistance of the arm-skate. In other words, when operating a arm-skate, in addition to drawing

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
25OCT2001	N/A	-

Title and Subtitle Aid Training System for Upper Extremity Rehabilitation	**Contract Number**
	Grant Number
	Program Element Number
Author(s)	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Department of Electronics Engineering, Hwa-Hsia College of Technology and Commerce	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es) US Army Research Development & Standardization Group (UK) PSC 803 Box 15 FPO AE 09499-1500	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes Papers from the 23rd Annual International conference of the IEEE Engineering in Medicine and Biology Society, October 25-28, 2001, held in Istanbul, Turkey. See also ADM001351 for entire conference on cd-rom., The original document contains color images.	
Abstract	
Subject Terms	
Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 4	

designs according to specific routes, resistance can also be applied. The resistance levels can be modulated according to the real demands to comply with the patients' physical conditions and the rate of training progress.

After the operator has set up the selected items and figures on the computer unit, specific designs linking with to each reed-relays will be displayed on the computer screen. The patients can then draw the same designs on the platform using the arm-skate with their hand. The correction and time elapsed can be recorded and sent back to the computer through signal converting interface. The training results will be saved in the patient database.

The circuit diagram of the system as shown in Fig.3, include a magnet, multiple reed-relays which are arranged as a 2-D array, a set of decoding and encoding circuits, and a microprocessor (89C51). Among them, magnet is placed at central position under the arm-skate operated by patients to react to the reed-relays under the operating platform. The reed-relays are arranged in a 2-D array that resembles to the keyboard circuit. The array scans if reed-relays are closed through the scanning circuit. The microprocessor generates a set of scanning signals to the reed-relays by its Port1 through the decoding circuit. If the reed-relays are closed, the Port2 receives another set of signals through encoding circuit. Therefore, the microprocessor can instantly read where the reed-relays operated by patients and respond to a closed circuit. Finally, the microprocessor is connected to the computer's communication port (COM1 through RS-232) through its serial transmitting port (Port3), transmitting data of reed-relays response to computer for analysis and processing.

The computer unit includes a processing unit, a indicating unit (screen), a input unit (keyboard, mouse) and a alarm unit. Its construction is the same as common computer, but can execute hand coordination training by using window software in connection the apparatus described above.

The concrete methods to take effect for the hand coordination training related above are mentioned in detail as follows. When performing hand coordination training, the patient seated in front of the platform. The patient supports one hand with the arm-skate, and then fixes the wrist with the sticky buckle on arm-skate. According to the system operation flow, when system starts, operator selects item "hand rehabilitation", and begins coordination training. On the computer screen there is a picture of a 2-D array displayed, composed by 45*25= 1125 plain pictures. Meanwhile, specific designs on arranged pictures, as related above, serve as orbit demonstrators of a rectangle, triangle, circle or symbol "∞". Patients look at the designs on the screen, move the arm-skate on the platform and draw routes that are the same as the appointed designs. While the arm-skate is moving, the magnet under it bottom will close the access to the reed-relays located at the corresponding position under the platform. The closing signal access for reed-relays will be sent back to the computer unit through signal converting interface.

The computer processes the route orbit contrast with specific designs generated using position signals gained from detection by the reed-relays. The differences in accuracy and time elapsed are calculated. If saving the information is not needed, return back to original state, and restart for training following the steps related above. If the information is saved, the rehabilitation training is saved as the contrast for the next training.

The hand coordinating training part can be proceeded repeatedly with patients according to the steps, using hand-training unit in connection with computer unit. Due to contrast correction function of this research, on the computer screen synchronically displays differences between the orbit and original appointed designs drawn on the platform. In other words, patients can use the synchronically display function on the computer screen and orbit correction sound effects of multimedia as patients' visual and audio feedback, instantly correcting the drawing design route. In the course of repeated training, patients' ability can be largely enhanced, further strength action the coordination of hand muscle.

III. CONCLUSIONS

The aid training system for upper extremity rehabilitation developed by this research has several features as follows:

1. By mean of drawing simple figures and lines, patients can easily practice rehabilitation training, and extend and bend the upper extremity, improving strength and coordination.
2. Using the instant correction function displayed synchronically by the computer unit, patients can be trained to improve their response of muscles, to reduce dullness during rehabilitation in connection with real clinical evaluation and friendly software interface.
3. Through connection with software and hardware, the course of instruction is be simple. Using a reed-relay as corresponding elements, other signals cannot interfere easily. The price is much lower than other measuring sensors (infrared or laser receiver), comparatively reducing the production cost.
4. The computer unit can calculate and record the training results for continuity, integrity and proportion. The time elapsed can be recorded for clinicians as a reference in rehabilitation medical care.
5. Easy to operate, training can be achieved without long and dull practice steps.
6. The system clinical trail now is processing in this research, and actually put it into practice with the hemplegics.

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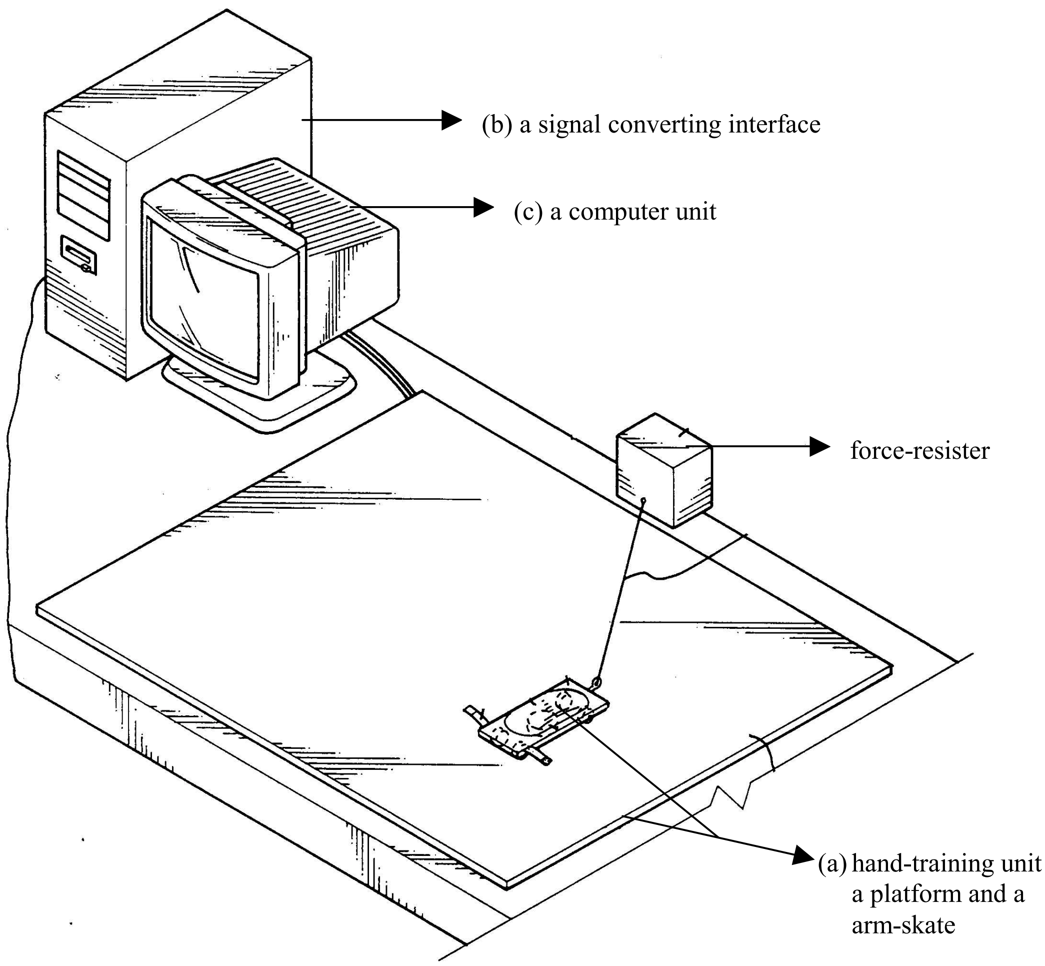

Fig.1 The configuration of the aid training system for upper extremity rehabilitation

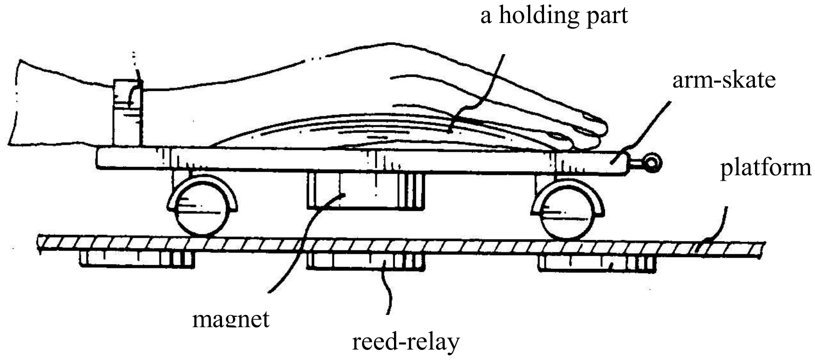

Fig.2 The arm-skate system for the patient in upper extremity rehabilitation

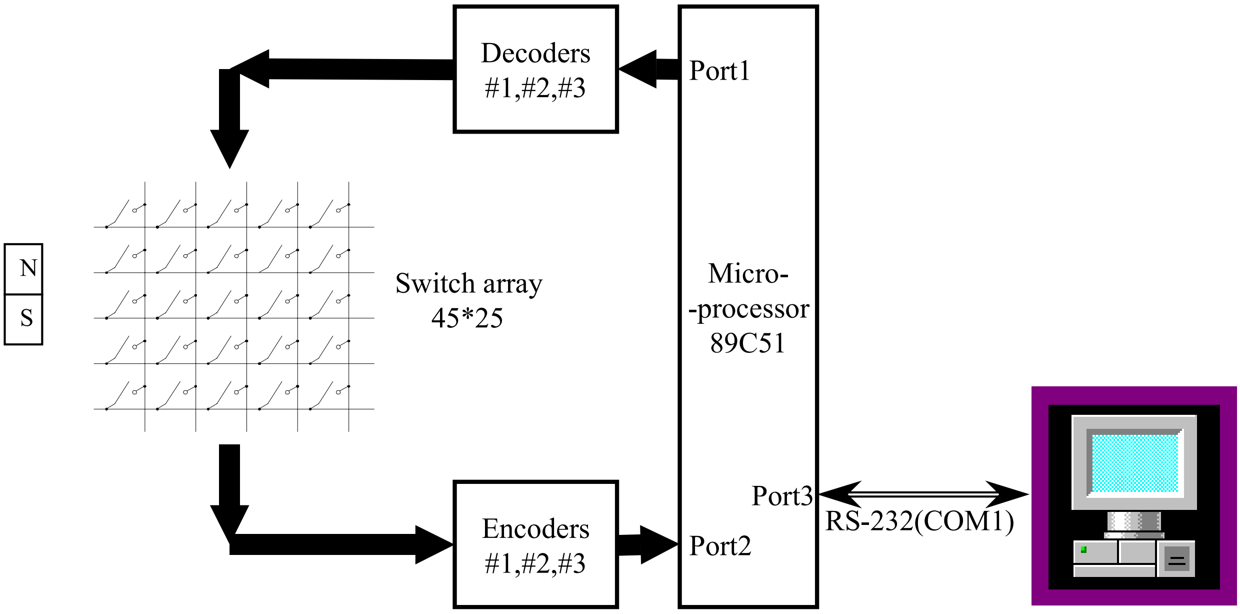

Fig.3 The circuit diagram of the upper extremity rehabilitation system